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BIOLOGY OF CYLINDROCOPTURUS LONGULUS [illegible] ON DOUGLAS FIR (PSEUDOTSUGA TAXIFOLIA (LAMB.) BRITT.)

Forest Insect Laboratory
445 U. S. Court House
Portland, Oregon
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By
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INTRODUCTION

Damage to Douglas fir by *Cylindrocopturus longulus* Lec. was first brought to our attention in 1935. In April of that year Prof. J. L. Alexander, then of the College of Forestry, University of Washington, pointed out a rather extensive infestation in a naturally established stand of 20-year-old Douglas fir growing on a gravely site at Pack Demonstration Forest, La Grande, Wash. This infestation was reported as having been in progress for several years, and, judging from the deformed condition of many of the trees, this was undoubtedly the case.

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* The identity of the species of *Cylindrocopturus* that attacks Douglas fir is in question. In a letter dated Jan. 22, 1940, Mr. L. L. Buchanan of the Division of Insect Identification states that the form on ponderosa and Jeffrey pine is distinct from the one on Douglas fir, but until a detailed study is made he is unable to definitely place either one. In the meantime, common usage has been followed in designating, as *C. longulus*, the insect that is discussed in this report.

** Acknowledgment is hereby gratefully made to the following persons who have contributed to this study: Mr. W. K. Coulter and Mr. W. R. Pierce assisted in collecting much of the field data in 1939. Mr. D. M. Covington, Resident Manager of Pack Demonstration Forest, provided numerous facilities for carrying on this study. Mrs. Kathryn Flaherty prepared the drawing of the adult *C. longulus* (fig. 8). Considerable manual labor was provided through the National Youth Administration project that is in residence at Pack Demonstration Forest.

Prof. Alexander suggested that a study be made to determine the present and potential importance of Cylindrocopturus longulus Lec. in the establishment of Douglas fir reproduction in the Pacific Northwest. In accordance with this suggestion, incidental observations on the habits of the weevil were made in Oregon and Washington from 1935 to 1937. Finally, through the establishment of a field laboratory at Pack Demonstration Forest it was possible to initiate a detailed study of the biology of C. longulus in 1938, and to complete it in 1939. The results of this study are outlined in this report.

TAXONOMIC STATUS

LeConte (1876) described Copturus longulus Lec. from specimens taken in California (Geysers), in Utah, and at Pettit, Canada. Heller (1895. Reference not seen.) proposed the name Cylindrocopturus which included longulus Lec. According to Leng (1920), Cylindrocopturus suppresses Copturus LeConte and Copturodes Casey. Casey (1897. Reference not seen.) proposed Copturodes and under it described subcupreus (Mass.), obscurellus (Colo.), nubilatus (Cal.), sucidus (No. Cal.), and dispersus (Can. and Ky.). Of these Casey species, Leng (1920) lists nubilatus and dispersus as valid varieties of C. longulus and the other three as synonyms. Van Dyke (1930) considers all of the above Casey species, and in addition lunatus LeConte, as color phases of C. longulus.

DISTRIBUTION AND HOSTS

In the broad sense recognized by Van Dyke, _C. longulus_ is an extremely widely distributed species. Its range includes practically all the coniferous forests of North America with the possible exceptions of those in the southern pine states, Alaska, and parts of Canada. Pierce (1907) under _Conturodes longulus_ Lec., states, "The larvae inhabit the galls of _Podapion gallicola_, but are mere messmates, and their presence is not detrimental to the welfare of the author of the gall (Schwarz 1894:15). One specimen of _Sigalphus coturi_ Riley was presumably bred from this species in a _Podapion gallicola_ gall on _Pinus inops_ June 2, 1883, at Washington, D. C." Van Dyke (1930) lists the following as host trees: _Pseudotsuga taxifolia_ (Lamb.) Britt., _Abies grandis_ Lindl., _A. concolor_ Lindl., _Pinus lambertiana_ Dougl., _Pinus murrayana_ Balf., and _Pinus radiata_ Don. Keen (1929) lists _Pinus jeffreyi_ (Vasey) as an additional host and records the eggs as being laid in the bark and the larvae as feeding on the bark of pines. Doane et al. (1936) report _C. longulus_ as occasionally doing considerable damage to various species of pine, fir, and Douglas fir. DeLeon (1935) reports it as often occurring on the bark of bark-beetle-infested _Pinus lambertiana_ Douglas and _Pinus ponderosa_ Lawson, but as probably more frequently attacking second growth.

In correspondence, DeLeon contributed the following additional information on hosts and distribution gained through his personal collections. Adults were reared from a small *Pinus ponderosa* taken at Capulin National Monument, New Mex., on Dec. 27, 1934. One adult was reared from *Pinus apacheca* Lemmon, Chiricahua National Monument, Ariz., in the fall of 1936. On Dec. 2, 1936, at Big Basin, Calif., one larva, presumably of this species, was cut from a lateral branch of *Pinus attenuata* Lemmon.

Records in the files of the Division of Forest Insect Investigations show that *Cylindrocopturus longulus* has been reared from the bole of *Larix occidentalis* (Nutt.) in the state of Washington and from *Tsuga mertensiana* (Raf.) Sarg. in Oregon. It has also been reared from *Pinus contorta* Loudon in Wyoming and Utah. Adults have frequently emerged in cages on the lower bole of mature *Pinus ponderosa* killed by *Dendroctonus brevicomis* Lec., but the role that the weevils play in such cases has not been determined. In 1930, Buckhorn noted injury of *Abies concolor* reproduction near Bly, Oreg., and in October 1931 Keen and Buckhorn found similar damage to *Pinus ponderosa* near Fort Rock, Oreg. Since 1935 numerous cases of infestation of *Pseudotsuga taxifolia* in western Oregon and Washington have been noted by the author.

CHARACTER AND IMPORTANCE OF ATTACKS ON DOUGLAS FIR

While *Cylindrocopturus longulus* seems to be common throughout the Douglas fir region, its presence can easily escape detection. Under ordinary conditions it attacks and frequently kills scattered twigs on open-grown reproduction. This type of infestation is not only inconspicuous but has no apparent effect upon the trees.

Where small Douglas firs are growing on certain types of gravely soil, such as at La Grande, Wash., weeviling may occur year after year, seriously deforming the trees and retarding their growth. (See figs. 1-4.) The laterals and terminals on such trees may be killed back as much as eight to ten years' growth. Some of the smaller trees, usually those less than five feet high, may be killed outright as a result of extremely heavy attacks.

An example of heavily attacked trees is afforded by a record of the weeviled branches that were present on 25 selected trees at La Grande, Wash., on April 30, 1938. The data relative to these trees are tabulated in table 1. This is of interest in that it shows the results of a heavy infestation of trees on a poor site under normal climatic conditions. From the table it is evident that as much as seven years' terminal or lateral growth was killed on the trees that were chosen. Other trees that were attacked only slightly heavier that those given in the table were killed outright.

Not all of the attacked branches are killed. Often the young brood stages are overcome by the resistance of the tree before the limbs are seriously affected (see discussion of host resistance, page 27). In other cases beetles may develop successfully without killing the infested branches. In the latter event, gall-like swellings often result above the larval mines. If subsequent attacks do not kill such branches, they will eventually recover. (See fig. 4A.)

General observations have shown that once Douglas fir reproduction has attained a height of 15 to 20 feet, weeviling causes no further appreciable damage. Only occasionally, and then on the lower branches, are trees over 20 feet tall attacked at all.

Following drought, injury caused by Cylindrocopturus longulus may increase to a very considerable extent, as was the case in the Rogue River Valley, Oreg., following the extremely dry summer and fall of 1936, and in the Puget Sound Basin following the very dry summer of 1938. In both of these cases many small trees growing on shallow or gravely soils were heavily attacked. This weeviling became so prevalent, especially in the prairie district of the Puget Sound Basin, that a great many requests were received concerning its cause and control. Here it is pertinent to note that small branches may become so desiccated from drought that the weevils do not develop successfully in them. In fact, drought injury may reach a point where its direct effects cause more damage to Douglas fir reproduction than does the increased amount of weeviling.

Table 1

Number of Branches Killed by *Cylindrocopturus longulus* on 25 Selected Douglas Fir Trees at La Grande, Wash., April 1938

Tree No.	Height in Feet	Basal Diam. in Inches	Greatest No. Years Growth Killed on Terminal*	No. Lateral Twigs Killed, Grouped by Amount of Growth Killed								
				1 Yr.	2 Yrs.	3 Yrs.	4 Yrs.	5 Yrs.	6 Yrs.	7 Yrs.	?	Total
1	3.8	1.2	3	2	3		1	2			1	9
2	4.0	1.2	7	1	2		1		1			5
3	4.0	1.2	4		5	1	2	1	1			10
4	3.7	1.0	4	2	3		3	1	1			10
5	4.5	1.2	5	2	4	2			2			10
6	4.7	1.4	3		4	1	3					8
7	4.1	1.0	2	3	1	3	5					12
8	4.3	1.1	6	2	1	1		1	2			7
9	3.6	.9	2	4	2			1	1			8
10	4.6	1.3	2	2	1	3	1	2	1			10
11	3.3	1.5	4		3	1	1	1		1		7
12	4.4	1.6	2	3	3	4						10
13	4.2	1.3	3		1	2	1		1			5
14	3.3	1.2	3	3	2	1						6
15	4.8	1.4	3	1	6	2	2			1		12
16	4.0	1.3	2	1	4	2						7
17	3.8	1.3	3		7	6	1					14
18	4.2	1.2	3	7	9	6						22
19	5.9	1.9	3	4	4	1	1	1				11
20	5.5	1.7	4	3	3	1						7
21	3.2	1.0	4		6	4	2	1				13
22	4.4	1.4	4	1	2	2	1	3				9
23	4.4	1.1	2	3	2	3	1	1	1			11
24	4.2	1.2	3	3	3	3	2					11
25	3.8	1.1	4	1	4	5		1	1			12
Range	3.2 – 5.9	.9 – 1.9	2 – 7									
Totals				48	85	54	28	16	12	2	1	246

* Terminal of some trees killed several times.

Because of the obviously minor importance of _Cylindrocopturus longulus_ in the Douglas fir region generally, no attempt was made to measure its actual effect either upon individual trees or upon stands of small trees. It is considered sufficient to point out that damage from weeviling may vary from scattered twig killing to the death of the attacked trees. The latter occurs only under very special site and climatic conditions, but under such conditions may be a considerable factor in the establishment of young stands, causing loss of growth in the early years and possible deficiency of stocking. Undoubtedly infestation by _C. longulus_ would be of greatest importance in plantations of Douglas fir where the survival and rapid growth of all trees is economically essential.

LIFE CYCLE

There is only one generation a year at La Grande, Wash. This was determined by caging studies and periodic sampling of the 1938-39 and the 1939-40 broods. The duration of the various stages is shown in graph 1.

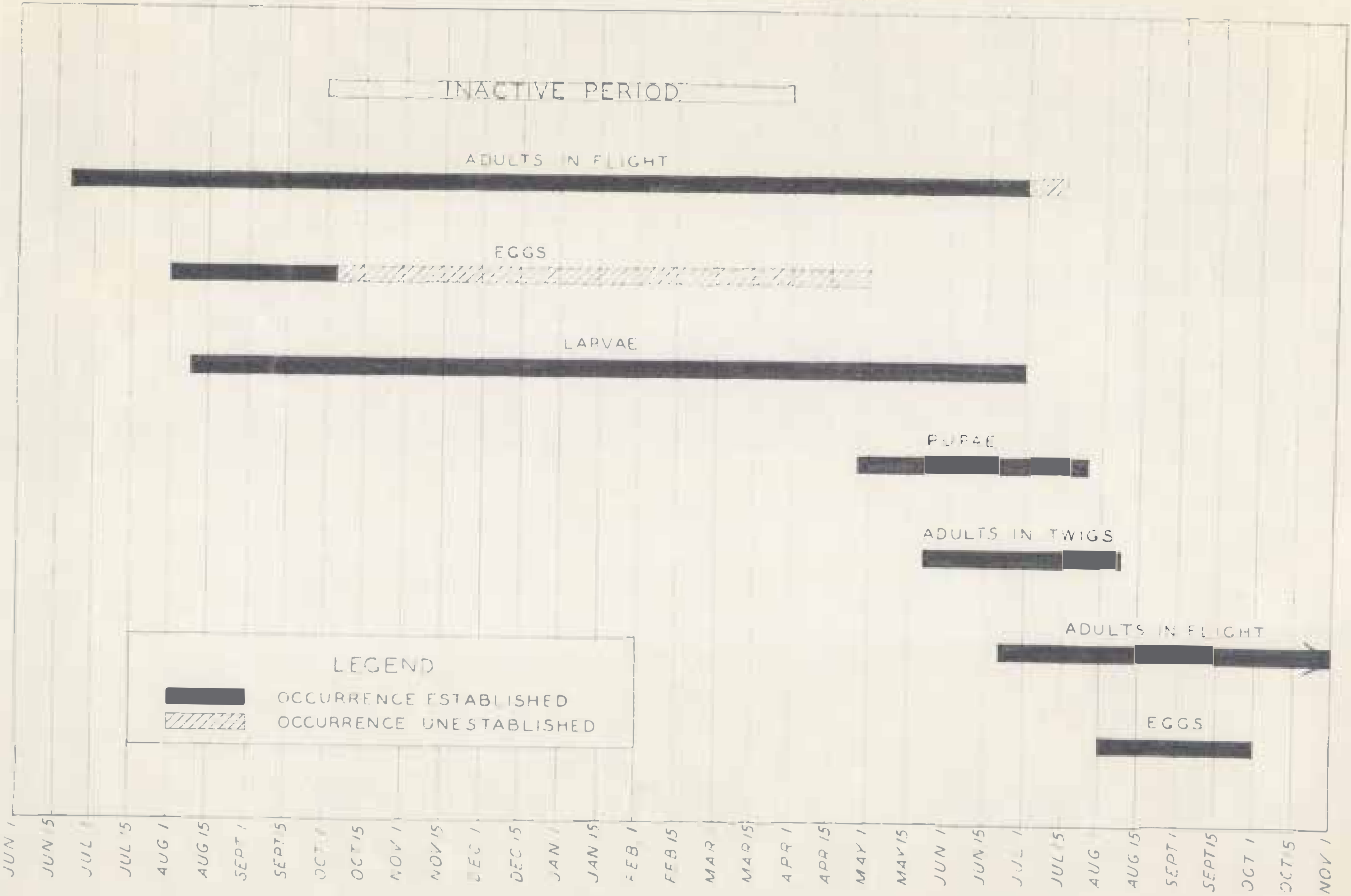
Eggs are laid from about the first of August to the first of October, although there is a very marked falling off after the middle of September. Incubation requires from one to two weeks. When development ceases in the fall, there are a few unhatched eggs. Presumably most or all of these die before the following spring.

The first small larvae appear about a week after the first eggs are laid and continue to develop until low temperatures occur in the fall. Practically all of the new brood pass the winter as larvae of various sizes in infested twigs. These range in size from first instar to mature larvae.

GRAPH I

LIFE CYCLE OF *C. LONGULUS* AT LA GRANDE WASH

BASED ON OBSERVATION OF THE 1938-39 AND 1939-40 BROODS



An indeterminate but rather large percentage of the parent adults apparently overwinter on Douglas fir reproduction by clinging to the branches in whatever sheltered situations are available.

Initial transformation of the larvae into pupae occurs during the last few days of April. The last transformations take place about July 1. The time of maximum pupal abundance is about June 10. By the end of the third week in July the last pupae have transformed into adults.

New adults are first formed by the third week in May and become most abundant in the twigs by July 5. Initial emergence occurs about June 20 and is completed by August 5. Very soon after emergence the adults begin feeding on the inner bark of Douglas fir twigs. There is a preoviposition period of approximately one month.

BROOD STAGES AND HABITS

Adult.

The adult (fig. 8) averages somewhat less than 2.5 mm. in length, is rather slender in outline, and is completely covered with scales except for the beak, antennae, and tarsi. The color of the scales is widely variable, but on the form attacking Douglas fir the basic color of the dorsal aspect is dark bronze, marked with scattered white scales and most commonly with an oblique, post-median, white band on each elytron. The ventral aspect is basically white, marked with scattered dark bronze scales. The legs are mottled bronze and white. The beak is piceous.

New adults first form about May 20, but initial emergence does not occur until about June 20. Soon after emergence, the adults feed on small Douglas fir branches by cutting irregular holes through the outer bark and gouging out the inner bark with the beak. The resulting feeding punctures cause small calluses which, when abundant, impart a characteristic roughened appearance to the twigs. In some cases where 30 to 50 adults were caged on branches of living trees these feeding calluses became so abundant that the branches were killed. Feeding continues as long as the beetles are active.

The exact length of adult life has not been determined. It is nearly certain, however, that some adults overwinter, for many have been beaten from reproduction in October, November, December, and January after general insect activity had ceased. Others have been similarly collected in April and May before any new adults had formed. One living adult was kept under observation in the laboratory from July 6, 1939, to January 1, 1940, a period of 179 days, or nearly six months. Several others were held in captivity for five months by frequently supplying them with fresh twigs. On November 5, 1939, fourteen adults were still alive in a lot of 44 that were caged on a living branch at La Grande, Wash., on June 20, 1939. The survivors had all lived at least 139 days and perhaps longer, for they were originally collected by beating. Very likely the percentage of survival in this case would have been greater had not the feeding punctures killed the caged branch, thus depriving the beetles of food

before the condition was noticed, and the beetles removed to another branch. At La Grande, Wash., early in November, 463 adults that had been caged on living branches from 1 to 3½ months were still alive. It is expected that a considerable number of these will overwinter successfully.

During the course of the study it proved desirable to locate suitable external characters for separating the sexes. Fortunately this proved to be an easy undertaking, for the first character that was hit upon was quite satisfactory. In order to orient this character it should be held in mind that the first and second abdominal segments are fused and together are approximately the same length as segments 3, 4, and 5 combined (see fig. 8). The separation is as follows:

Female: The median ventral impression on the first abdominal segment not extending to the basal margin.

Male: The median ventral impression on the first abdominal segment extending to the basal margin, often continuous with a posterior impression on the metasternum. Impression much larger and deeper than on the female.

While this character may seem somewhat vague, examination of a relatively few adults will show that it can readily be used with a high degree of accuracy. It will also be found that some rather intangible considerations, such as the generally more inflated

abdomen of the female, aid in the separation of the sexes. The results, obtained in this study by separating 793 individuals on the basis of the above external character and then dissecting them to definitely determine the sex, show the degree of accuracy that can be expected in separating the sexes by an external examination. Five hundred and three females and 288 males were correctly identified. Two females were misidentified as males. The error in this case was 0.25 percent. It should be stated here that about 1 in 100 individuals is intermediate and difficult to separate sexually by an external examination. Separation of the sexes of living adults is fairly easy for the adults are not especially active except at high temperatures.

Relatively little information is available concerning the proportion of the sexes at the time of emergence. In table 2 is shown the number of males and females that emerged from several lots of infested branches. A total of 686 adults emerged, of which 51.2 percent were females and 48.8 percent were males, indicating a probable proportion of 1:1.

From June 20, 1939, through January 4, 1940, many adults were collected by beating Douglas fir reproduction at La Grande, Wash. (This method of collection is one commonly used by entomologists. In this case the technique consisted of placing a 30 x 48 inch cloth-covered frame on the ground beneath a chosen tree and then hitting the tree sharply several times with a section of a shovel handle. The weevils that fall upon the beating frame were immediately

collected.) The sex of 2,532 adults obtained in this manner was determined, and it was found that 44.2 percent were females and 55.8 percent were males (see table 3). Apparently there is a consistent but slight predominance of males in field collections of the type made at La Grande.

Table 2

Sex of Cylindrocopturus longulus adults reared from Douglas fir branches

Locality	Date of Host Material Collection	Female Emergence No.	Female Emergence Percent	Male Emergence No.	Male Emergence Percent	Total Emerg. No.	Total Emerg. Percent
La Grande, Wash.	5/22/35	72	46.8	82	53.2	154	100.0
Oswego, Oreg.	6/6/35	0	0.0	2	100.0	2	"
Gasquet R.S., Calif.	5/21/37	62	50.8	60	49.2	122	"
Gasquet R.S., Calif.	5/22/37	12	60.0	8	40.0	20	"
Shelton, Wash.	4/12/39	21	53.8	18	46.2	39	"
La Grande, Wash.	5/22/39	92	53.8	79	46.2	171	"
La Grande, Wash.	5/26-27/39	46	55.4	37	44.6	83	"
La Grande, Wash.	6/2-3/39	46	48.4	49	51.6	95	"
Totals		351	51.2	335	48.8	686	100.0

Table 3

Sex of Cylindrocopturus longulus Adults Collected by Beating Douglas Fir Reproduction at La Grande, Wash., 1939-1940.

Collection Date	Females Collected No.	Females Collected Percent	Males Collected No.	Males Collected Percent	Total Collected No.	Total Collected Percent
6-20-39	28	32.6	58	67.4	86	100.0
6-27-39	41	38.3	66	61.7	107	"
7-6-39	36	35.0	67	65.0	103	"
7-11-39	24	30.0	56	70.0	80	"
7-18-39	51	47.7	56	52.3	107	"
7-25-39	52	44.4	65	55.6	117	"
8-1-39	38	34.2	73	65.8	111	"
8-2-39	17	33.3	34	66.7	51	"
8-5-39	15	38.5	24	61.5	39	"
8-8-39	141	43.4	184	56.6	325	"
8-9 & 10-39	37	49.3	38	50.7	75	"
8-15-39	75	46.6	86	53.4	161	"
8-22-39	91	48.1	98	51.9	189	"
8-29-39	56	49.6	57	50.4	113	"
9-5-39	13	61.9	8	38.1	21	"
9-6-39	34	46.6	39	53.4	73	"
9-12-39	43	52.4	39	47.6	82	"
9-19-39	63	50.0	63	50.0	126	"
10-4-39	53	42.7	71	57.3	124	"
11-3-39	33	44.6	41	55.4	74	"
11-7-39	36	45.0	44	55.0	80	"
11-20-39	39	44.3	49	55.7	88	"
12-6-39	46	59.0	32	41.0	78	"
12-19-39	30	42.9	40	57.1	70	"
1-4-40	27	51.9	25	48.1	52	"
Totals	1,119	44.2	1,413	55.8	2,532	100.0

Egg.

The egg (fig. 5) is ovoid, pearly white, and without surface markings. There is considerable variation in the general outline, probably because of the effect of irregularities in the walls of the cavities in which the eggs are deposited. The average dimensions of 20 eggs measured on Sept. 5, 1939, were: length, .483 mm., and width, .296 mm.

The actual process of egg laying was not observed; however, 4,389 eggs were dissected from twigs and practically all were found to have been deposited in the same manner. A small oblique hole, approximately the size of the egg, is cut beneath the bark, the egg is laid, and a white secretion is deposited to close the opening. The presence of this white plug serves to distinguish the egg punctures from the feeding punctures, which are open and more irregular in shape. In the laboratory a few eggs were laid on the surface of twigs after they had become excessively dry.

From table 1 it is evident that eggs may be deposited in any of the last seven years' growth, for the larvae seldom extend their mines more than an inch or two from the egg niche. Hence, it is virtually certain that the eggs were deposited very near the point where the beetles killed the branches. In the field Cylindrocopturus longulus has been found as far back as the tenth internode. There is, however, a marked preference for more recent growth so that a very large proportion of the eggs are laid in the last four years' growth. The next to the last year's growth has been observed to be most heavily attacked. The eggs are about evenly distributed

along a given year's growth with the exception of the current growth. In the latter case they are seldom found in the rapidly growing portion and are most abundant near the base of the internode.

As stated previously, the egg-laying period in the field extends from about the first of August to the first of October. The beginning of egg production was checked rather carefully (1) by examining random twig collections during June, July, and August; (2) by examining twigs upon which weevils were caged in the laboratory; and (3) by dissecting females. No mature eggs were found in dissected females until August 2. Subsequent dissections during August usually revealed from 1 to 6 mature eggs. On August 3 a field collection of twigs yielded 3 eggs. Between August 2 and 9 numerous eggs were deposited in caged twigs in the laboratory by adults that had previously been under observation from 8 to 22 days.

One notable exception was found on July 13 when three very small larvae were cut from a caged tree upon which attacks were forced in 1938. Whether these larvae developed as a partial second brood, established by overwintering adults, or were established by new adults, is not known. Obviously they did not belong to the 1938-39 generation. No similar example of such early development was observed on uncaged trees, although they were intensively sampled during July to determine the time of earliest egg deposition.

Occasional observations of oviposition in 28 caged branches on living trees revealed that egg laying continued at a fairly high level until about the middle of September and then dropped rapidly until it ceased by the end of the first week in October.

In the laboratory it was possible to extend the egg-laying period about three months beyond that in the field by maintaining the beetles at room temperatures and by frequently supplying them with freshly cut sections of Douglas fir twigs. In table 4 is given the record of egg production of 175 adults (72 females and 103 males) that were kept in glass jars and supplied with fresh food on the dates given at the top of the table. No attempt was made to control humidity in the jars. Under these conditions oviposition continued from August 9, 1939, to January 1, 1940. Peak productivity occurred about the time that egg laying ceased in the field. Mortality among the caged beetles was high because of the necessity of frequent handling, and because many became fouled in pitch from the cut ends of the twigs.

It is not known whether egg laying is resumed in the spring, but dissection in late fall revealed that few females contain mature eggs after the second week of September. (See table 5.) One female collected on November 20, 1939, contained two mature eggs and another female collected on December 19, 1939, contained one mature egg. Two hundred and forty-one other females collected between October 4, 1939, and January 4, 1940, contained no mature eggs.

Designation	Date Caged	Female	Male	July 21	25	30	August 1	2	3	8	9	10	11	14	15	16	17	18	19	20	21
"7-6-39"	7-13-39	8	6	*			* -		-	-	6	-	-	6	6	5	-	7	4	14	2
"7-6-39"	7-13-39	5	12				-		-	-	12	-	-	-	22	10	20	5	5	24	14
"7-13-39"	7-13-39	7	6				-		-	-	1	-	-	-	1	4	-	4	-	-	4
"7-18-39"	7-21-39	11	24				-		-	-	5	-	-	-	7		-	4	6	5	5
"8-1-39"	8-3-39	19	23	-	-	-	-	-	-	-		-	-	-	5	7	-	2	8	13	9
"8-8-39"	8-8-39	19	29	-	-	-	-	-	-	-	-	5	-	-	18	21	13	4	3	14	23
C-4	8-8-39	1	1	-	-	-	-	-	-	-	-	-			-		-	2	1	1	
C-5	8-8-39	1	1	-	-	-	-	-	-	-	-	-			-		-				
C-9	8-8-39	1	1	-	-	-	-	-	-	-	-	-	2	1	-	2	-	2		2	1
Totals		72	103								24	5	2	7	59	49	33	30	27	74	58

* - = no examination.

blank = no emergence.

Table 4

Egg Production of 175 (72 Female and 103 Male) <u>Cylindrocopturus longulus</u> adults
July 13, 1939, to January 1, 1940.

Number of Eggs Laid by Dates																														
August										September																October				
22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	9	11	13	15	17	19	23	25	28	1	3	7	9	14
5	11	8	14	7	4	5	5	10	3	8	3	5	4	3	4	8	8	5	10	1	18	9	23	4	13	29	25	40	10	27
16	11	17	8	6	7	8	7	1	1	3	3	2	10	4	2	3	3	5	14		2	4	11	8	10	4	6	9	2	4
-	-	-	29	19	7	8	16	10	14	4	8	9	12	7	6	5	14	15	17	7	23	10	43	16	51	39	47	49	26	69
14	5	15	2	16	8	13	10	6	11	7	5	10	15	11	7	10	17	5	20	18	29	15	54	57	45	51	38	57	9	42
12	15	33	16	11	23	6	15	7	16	5	7	4	16	7	8	6	14	4	17	6	15	8	24	9	6	22	9	35	21	28
23	16	28	3	9	7	10	7	6	10		5	12	8	6	4	9	4	3	12	1	6	2	24	28	31	31	28	44	32	53
				3	-	-	2	-	-	-		-	-	-	11	3	2		3		1		3	9	3	10	1	4	5	8
					-	-		-	-	-		-	-	-	9	3		1	4	5	1	3	6	10	6	9	6	10	10	16
3			2	2	1	2	2	1	1	1	1		2		1	1	3		3	2	1		7			2	4	11	1	11
73	58	81	74	73	57	52	64	41	56	28	32	42	67	38	52	48	65	38	100	43	96	51	195	141	165	197	164	259	116	258

					November								December								Jan.	Date	Total No.	Av. No. Eggs Laid
17	21	23	27	31	4	8	11	15	18	21	25	28	2	5	10	13	17	20	24	27	1	Closed	Eggs	per Female
23	17	8	9	3	2																	1-8-40	444	56
2	6	2	1	1	3																	11-15-39	318	64
55	67	36	40	26	13	9		3	3	4	6	4	2									12-5-39	862	123
25	22	11	5																			11-11-39	717	65
24	22	1	7	1	3	7		3	4	7	9	21	26	14	4	6	13	8	9	2	9	1-8-40	649	34
39	28	2	12	5	3	5	8	10	9	10	11	13	8	10	14	2	5	6	7			1-1-40	770	41
7	10	2	10	14	16	7	3	5			8	7	9	6	8							12-13-39	184	184
5	11	4	5	8	6	4		4														11-18-39	147	147
3	3																					10-27-39	81	81
183	186	66	89	58	46	32	11	25	16	21	34	45	45	30	26	8	18	14	16	2	9		4172	58

Table 5

Summary of Mature Eggs Dissected from 365 Female *Cylindrocopturus longulus* Collected at La Grande, Wash., August 8, 1939, to January 1, 1940.

Collection Date	Total No. Females Dissected	Number of Mature Eggs						
		0	1	2	3	4	5	6
8-15-39	23	3	7	6	3	3		1
8-29-39	2			1	1			
9-5-39	6	6						
9-6-39	10	8		2				
9-12-39	42	26	9	4	1	2		
9-19-39	39	33	4	2				
10-4-39	33	33						
11-3-39	33	33						
11-7-39	36	36						
11-20-39	39	38		1				
12-6-39	45	45						
12-19-39	30	29	1					
1-4-40	27	27						
Total	365	317	21	16	5	5	0	1

No attempt was made to determine the number of eggs laid by an individual female in the field. In the laboratory, however, a careful record was made of egg production. As shown in table 4, one female isolated with one male laid 184 eggs in 116 days, or an average of 1.5 eggs per day. This was the highest total productivity for any female. Another female produced 147 eggs in 88 days, to average 1.6 eggs per day. One group of 7 females and 6 males laid 862 eggs, or an average of 123 eggs per female. Some isolated pairs laid very few eggs and some produced none at all.

Mating occurred frequently among the caged beetles and seemed to be essential to the continued production of eggs. Productive females discontinued laying eggs within a few days after being deprived of association with males.

Incubation was observed only in the laboratory. Eggs were obtained by caging adult weevils in glass jars on sections of freshly cut Douglas fir twigs from the 1938 internode. Feeding and oviposition were allowed for one to several days. At the end of this time the eggs were removed from the bark and placed upon moist blotting paper in salve boxes, which were then closed and kept at room temperatures. Daily observations were made of 360 eggs treated in this manner. Under these conditions 271, or 75.3 percent, hatched. Probably the 89 that died do not represent normal egg mortality, but rather the effects of improper handling, for as technique was improved mortality became negligible.

During August, 193 eggs of known age were isolated and kept under daily observation. The incubation period for these eggs is shown in table 6. It was noted that eggs that were kept at the Portland laboratory practically all hatched in 6 to 8 days, while those kept at Pack Forest took 9 to 13 days. (Temperatures at Pack were lower and more nearly approximated outdoor temperatures.)

It is of particular interest that the eggs laid in the laboratory after egg laying had ceased in the field were also fertile and apparently remained so until the last eggs were laid. (See table 7.)

<u>Larva.</u>

The mature larva (fig. 6) of <u>Cylindrocopturus longulus</u> is of the same facies as <u>C. crassus</u> described by Keifer (1930). It differs from the latter in having a prominently pigmented area on each gena and by the presence of a small subapical tooth on the cutting surface of each mandible.

Dr. W. H. Anderson of the Division of Insect Identification has been asked to prepare a detailed description of the larva and pupa of <u>C. longulus</u>. In the meantime, the following generalized description is submitted:

The larva is 3.0 to 3.5 mm. long and about 1.2 mm. in maximum width. The body is curved, subcylindrical, and tapers only slightly posteriorly. The color is white except for the head, which is light testaceous with darker mouth parts. No hairs are evident

at 85X magnification, except scattered setae which are most noticeable on the head, prothorax, pedal lobes, and the dorsum of segments 6, 7, and 8. The body integument is generally covered with minute rugosities that, for the most part, are barely discernible at 85X. These rugosities are most prominent on the posterior third of the prothoracic shield. There are nine pairs of bifore spiracles, one pair on the mesothorax and one pair on each of the first eight abdominal segments. The head is elongate oval and strongly retracted into the prothorax. The frons, which is distinctly separated from epicranium by the lateral branches of the epicraneal suture, is approximately as long as wide and is produced posteriorly in an acute angle. The antennal lobe is small and located at the epicraneal suture near the articulation of the mandible. The inconspicuous ocellus is on the epicranium just posterior to the antenna. Posterior to the ocellus is a prominent, darkly pigmented marking. The labrum is widely and deeply emarginate. Each mandible bears a small subapical tooth. There are about eight stout setae on the maxillary malla. The epipharyngial rods converge in a narrow V and are widest at the point of juncture.

The prepupal larva (fig. 7) differs from the mature larva by the body being less curved and by the head being exserted.

Table 6

Incubation Period for Cylindrocopturus longulus Eggs

No. Days	No. Eggs Hatched
4	1
5	0
6	32
7	21
8	26
9	47
10	45
11	13
12	6
13	2
Total	193

Table 7

Incubation of Cylindrocopturus longulus Eggs Laid during Late Fall and Winter

Date Eggs Isolated	No. Isolated	No. Hatched
10/17/39	22	22
10/24/39	23	19
11/18/39	3	3
12/20/39	5	3

Upon hatching, the small larvae soon bore down to the surface of the wood where they usually extend their galleries longitudinally for a variable distance. As the larvae grow, their galleries become winding. If a node is encountered it may be encircled and killed. This is the most frequent cause of the death of small twigs. As the galleries are extended the bark above them shrinks, causing a characteristic callus which indicates the presence of attacks considerably before any foliage fades. On large branches coalescence of several of these calluses is necessary before the branch is killed. When the larvae approach maturity, they frequently bore through the wood into the pith and may mine in the pith for an inch or two.

As stated previously, larvae of all sizes overwinter. No information is available on the length of life of individuals, but from a study of the life history chart it can be seen that the average must be about nine months.

Pupa.

The pupa does not differ from the typical curculionid pupa. It is white, about 3.5 mm. long, and bears only a few setae which are inconspicuous even at 85X magnification. (Dr. W. H. Anderson has been asked to prepare a detailed description of the pupa.)

Pupation may occur in the bark, in a cell in the wood, or in the pith. The smaller the twig and the thinner the bark, the more likelihood that pupation will occur either in the wood or in the pith.

Pupation occurs in the spring, chiefly during May and June (graph 1). Ninety-eight prepupal larvae were individually reared to the adult stage in the laboratory in order to determine the length of the pupal stage. Each of these larvae was placed in a small glass vial which was plugged with cotton and moistened daily. A total of 98 adults (46 females, 49 males, and 3 the sex of which was not determined) developed. The period covered by these observations extended from May 31 to July 21. The minimum time for development in the pupal stage was 14 days, the maximum 27 days, and the average 22 days. Actually the length of the developmental period varied but little in the vast majority of cases (table 8). Reference to the life history chart indicates that the duration of the pupal period was probably not much different in the field than in the laboratory.

Table 8

Duration of Pupal Stage of 98 Reared _Cylindrocopturus longulus_.

No. Days in Pupal Stage	No. Adults Formed	No. Days in Pupal Stage	No. Adults Formed
14	1	22	22
15		23	22
16		24	3
17		25	
18		26	4
19	1	27	1
20	16	Total	98
21	28		

FUNGUS ASSOCIATION

The ability of very small *Cylindrocopturus longulus* larvae to overcome the resistance of branches on apparently vigorous trees indicated the possibility of an association with some active fungus similar to the species of *Ceratostomella* that occur with certain Scolytidae. Furthermore, it was repeatedly noted that a characteristic browning of the phloem around the larval mines, similar to that around scolytid galleries, was commonly associated with the work of *C. longulus*. When a report was received that Dr. C. T. Rumbold had isolated a wood-staining fungus, *Pullularia pullulans*, from *C. longulus* on Jeffrey pine submitted from California by Mr. C. B. Eaton, similar material from Douglas fir at La Grande, Wash., was sent to her for study. Cultures of *P. pullulans* developed from this material and are still under observation at Madison, Wis. Isolations were made from larvae, adults, and feeding punctures. Whether *P. pullulans* is the agent that is directly responsible for the death of Douglas fir branches that are attacked by *C. longulus* is not yet known. It may be pertinent, however, that the fungus is obviously introduced into the feeding punctures, yet under normal conditions only a small callus results. Under cage conditions, as has been previously pointed out, an excessive number of feeding punctures may actually cause the death of a branch.

CONTROL

Natural Control.

There are several important factors which limit the abundance of Cylindrocopturus longulus. These are so effective that the weevil is ordinarily of no economic significance on Douglas fir despite the fact that it has a rather high reproductive capacity and is able to develop successfully in trees of seemingly vigorous growth. No detailed study was made of the actual effectiveness of each of these factors. Very likely their relative importance is variable from year to year. Factors which were observed as operative against C. longulus were: host resistance, competition, and parasitism.

Host resistance. In this case, host resistance is the "pitching out" of eggs and small larvae. By the time that larval feeding ceases in the fall, a rather high mortality has occurred. Most of this can be attributed to excessive pitch flow which overcomes the eggs and small larvae. Insufficient data were taken to evaluate accurately the actual effectiveness of host resistance. However, an indication of its importance is furnished by the percentages given in table 9. Practically all of the dead eggs and the unparasitized dead larvae shown in this table succumbed to excessive pitch flow. It should be noted here that the actual number of dead eggs was probably much greater than the number recorded. This is because of the extreme difficulty in recognizing dead eggs among the multitude of feeding scars that are invariably present on infested branches. The eggs that were listed as being alive were the only turgid ones encountered and may or may not have been actually alive.

Table 9

Status of *Cylindrocopturus longulus* Brood
as Determined at La Grande, Wash., Fall of 1939

No. Branches Examined	Date Examined	Live Eggs No.	Live Eggs %	Dead Eggs No.	Dead Eggs %	Unparasitized Dead Larvae No.	Unparasitized Dead Larvae %	Parasitized Larvae No.	Parasitized Larvae %	Live Larvae No.	Live Larvae %	Total Brood
25	10/7-10/39	2	0.3	34	5.3	273	42.9	122	19.2	206	32.3	637
4	11/10/39	3	2.1	18	12.6	90	62.9	4	2.8	28	19.6	143

Competition. Competition is largely for suitable food. When the brood enters the winter period there may be 20 or more unparasitized, living, *Cylindrocopturus longulus* larvae in a single internode of a given twig. For the most part host resistance has been overcome by this time. (Consequently, there is little additional mortality from that cause.) The likelihood is that only one to three, and perhaps no, adults will emerge in the spring from such a section of infested twig. Obviously there is a high mortality among the individuals that enter the winter as living larvae. Some of this is undoubtedly caused by additional parasitism, but it is largely the result of competition.

Living larvae of all sizes are present when the winter period of inactivity begins. At that time some individuals have reached maturity and have entered the wood preparatory to pupation in the spring. If the bark surface overlaying the mine of one of these large larvae is examined, it will often be found that several other

eggs were laid there and either had failed to hatch or the young larvae had died as a result of direct competition with the larger larva. Frequently the large larva girdles the infested twig, causing the bark to become dry beyond the girdle. Unless the larvae in the dried-out section have nearly reached maturity, they will die from lack of suitable food.

Parasitism. Parasitism of *Cylindrocopturus longulus* is fairly common. Most of the parasites attack the host larvae or occasionally the pupae, but one species overwinters as a larva in the host adult. In all, 12 hymenopterous parasites have either been definitely proven as parasitic, or have been linked as being very likely parasitic on *C. longulus* in northern California and Washington. These parasites are listed in table 10.

Egg deposition by the parasites was not observed, but table 9 shows that some parasitism occurs in the fall. At that time three or more species have been observed in the host mines, but only one species, *Euderus argyresthiae*, has been identified. Five females and seven males of this parasite were reared in the laboratory during October and November 1939, from larvae that were isolated early in October of the same year. Other parasitic larvae that were collected in the fall failed to transform to adults.

Table 10

Parasites Associated with _Cylindrocopturus longulus_ on Douglas Fir in northern California and Washington

Species	Distribution	Abundance	Relationship to _C. longulus_
Braconidae			
Dendrosoter scaber Mues.	California	Common	Probable parasite
Microbracon pini Mues.	Calif., Wash.	Scarce	Proven larval parasite
Urosigalphus pini Cush.	California	Common	Probable parasite
Chalcidoidea			
Amblymerus verditor Nort.	Calif., Wash.	Scarce	(Proven larval
Cecidostiba sp.	Washington	Scarce	(parasite
Euderus argyresthiae (Cwfd.)	California	Common	" " "
Eupelmella vesicularis (Rets.)	Washington	Scarce	" " "
Eurytoma sp.	Washington	Scarce	" " "
Tetrastichus sp.	Washington	Scarce	" " "
Rhopalicus pulchripennis Cwfd.	Calif., Wash.	Common	" " "
Ichneumonidae			
sp. (?)	Washington	Scarce	" " "
Unknown			
sp. (?)	Washington	Common	Proven adult parasite

Presumably, additional parasitism occurs in the spring. In table 11 is given the degree of parasitism as determined by periodic sampling of the 1938-39 generation during the spring and summer of 1939. There is a considerable error in this table because all the dead eggs and probably many of the very small dead larvae were overlooked.

A few general observations on the various species of parasites resulted from rearing two lots of weevil-infested Douglas fir taken near Gasquet Ranger Station, Del Norte County, Calif., and from rearing individual parasites that were isolated from Cylindrocopturus longulus galleries in Douglas fir at La Grande, Nisqually, Puyallup, and Toledo, Wash. In the latter case the host-parasite relationship is established, but in the former the relationship is only probable. The following are a few brief notes on the parasites that are herein associated with C. longulus.

Dendrosoter scaber Mues. Common, California. The type of D. scaber was described by Muesebeck (1938) from adults that were reared during June and July 1937 from Douglas fir branches taken near Gasquet Ranger Station, Calif. Since Cylindrocopturus longulus was responsible for the death of these branches, it was assumed to be the host of D. scaber.

Table 11

Status of Cylindrocopturus longulus Brood as Determined at La Grande, Wash., Spring and Summer 1939

Date Examined	Locality (Wash.)	* Living C. longulus No.	%	Dead, unparasitized C. longulus No.	%	Parasitized C. longulus No.	%	Total C. longulus No.	%
Apr. 3, 1939	La Grande	116	75.3	28	18.2	10	6.5	154	100.0
" 15, 1939	La Grande	25	53.2	15	31.9	7	14.9	47	"
" 13-20	Nisqually	63	55.8	12	10.6	38	33.6	113	"
" 15-20	Toledo	28	37.3	37	49.4	10	13.3	75	"
" 20-25	Puyallup	181	80.8	14	6.3	29	12.9	224	"
" 25	La Grande	42	72.4	5	8.6	11	19.0	58	"
" 27-29	La Grande	100	80.7	3	2.4	21	16.9	124	"
May 3	"	52	56.5	25	27.2	15	16.3	92	"
" 10	"	32	72.8	6	13.6	6	13.6	44	"
" 18-19	"	58	42.6	20	14.8	58	42.6	136	"
" 26	"	27	65.8	2	4.9	12	29.3	41	"
" 31	"	221	95.7	2	.9	8	3.4	231	"
June 8	"	123	85.4	8	5.6	13	9.0	144	"
" 15	"	51	62.2	23	28.0	8	9.8	82	"
" 22	"	47	46.5	31	30.7	23	22.8	101	"
" 29	"	62	59.0	21	20.0	22	20.9	105	"
July 5	"	43	46.7	42	45.7	7	7.6	92	"
" 13	"	49	33.8	71	49.0	25	17.2	145	"
" 20	"	53	44.5	46	38.7	20	16.8	119	"
" 27	"	48	51.1	35	37.2	11	11.7	94	"
Aug. 4	"	37	40.6	43	47.3	11	12.1	91	"
" 10	"	55	55.6	33	33.3	11	11.1	99	"
Totals		1513	62.8	522	21.6	376	15.6	2411	100.0

* Includes emergence.

Microbracon pini Mues. Uncommon—California, Washington. Two adults were reared on June 12, 1937, from Douglas fir limbs infested by Cylindrocopturus longulus near Gasquet Ranger Station, California. One fully formed adult was removed in its cocoon from a larval mine of C. longulus in a Douglas fir branch collected at Toledo, Wash., on April 12, 1939. M. pini is also recorded as an important parasite of Pissodes strobi Peck.

Urosigalphus pini Cush. Common—California. Presumably it is parasitic on Cylindrocopturus longulus. Adults were reared during June, July, and August 1937, from two lots of Douglas fir branches collected near Gasquet Ranger Station, Calif.

Amblymerus verditor Nort. Fairly common—California. Uncommon—Washington. Adults were reared during June 1937 from Douglas fir branches collected near Gasquet Ranger Station, Calif. Larvae were taken from the larval mines of Cylindrocopturus longulus at La Grande and Toledo, Wash. The pupal period of two reared individuals was 13 and 15 days. Adults were noted from April 30 to June 22. Gahan (1932) reports A. verditor as parasitic on Neodiprion, Diprion, and Harmologa fumiferana. In the Portland station records it is listed as a parasite of Peronea variana, Stilpnotia salicis, and Neodiprion tsugae.

Cecidostiba sp. Uncommon—Washington. This undetermined species was reared from C. longulus larvae from La Grande, Nisqually, and Puyallup, Wash. The pupal period of three reared individuals ranged from 13 to 17 days. Adults were noted from April 9 to August 14.

Euderus argyresthiae (Cwfd.). Common—Washington. This was the most abundant parasite of *Cylindrocopturus longulus* larvae at La Grande, Nisqually, Puyallup, and Toledo, Wash. The pupal period of 28 individuals ranged from 11 to 22 days. Adults were reared from the 1938-39 generation of *C. longulus* from April 18 to July 29, 1939. Adults were reared in the laboratory during October and November 1939 from the 1939-40 generation of *C. longulus*. In the latter case, the parasites would have overwintered as larvae had they been left in the field.

Eupelmella vesicularis (Retz.). Uncommon—Washington. A few were reared from *Cylindrocopturus longulus* larvae from La Grande and Puyallup, Wash. The pupal period of six individuals ranged from 10 to 18 days. Adults were noted from June 28 to July 22. Gahan (1933) says of this species, "This is apparently one of the most polyphagic species of all chalcidoids, its hosts embracing Diptera, Coleoptera, Hymenoptera, Lepidoptera, Homoptera, and Orthoptera." It is a primary and secondary parasite of the hessian fly. Our records show it from the galls of *Diastrophus kincaidii* Gill. on *Rubus parviflorus* at La Grande, Wash.

Eurytoma sp. Uncommon—Washington. A few were reared from *C. longulus* larvae from La Grande and Puyallup, Wash. The pupal period of six individuals ranged from 10 to 13 days. Adults were noted from April 25 to August 5.

Tetrastichus sp. Uncommon—Washington. Two adults were reared on May 15 and 16, 1939, from larvae of Cylindrocopturus longulus collected at Puyallup, Wash.

Rhopalicus pulchripennis Cwfd. Common—California, Washington. Adults were reared during June 1937 from Douglas fir limbs infested by Cylindrocopturus longulus near Gasquet Ranger Station, Calif. It was also reared from C. longulus larvae taken at La Grande, Nisqually, Puyallup, and Toledo, Wash., where it was second to Eudorus argyresthiae in abundance. At Gasquet Ranger Station, Calif., R. pulchripennis was less abundant than Dendrosoter scaber and Urosigalphus pini. It is reported as a minor parasite of Pissodes strobi. Our records show it as a parasite of P. sitchensis at Astoria, Oreg.

Ichneumonidae sp. Uncommon—Washington. Three adults were reared during June 1939 from C. longulus larvae taken at La Grande, Wash.

Hymenoptera undetermined sp. Common—Washington. Dissections of 316 overwintering parent adults taken by beating Douglas fir reproduction at La Grande, Wash., have shown that approximately 10 percent of them contain an internal hymenopterous parasite. In all except one case, noted so far, there has been only a solitary parasitic larva. The single exception contained two parasitic larvae, one of which was dead. Table 12 shows the parasitism by this undetermined species as determined by dissections of adults that were collected from September 12, 1939, to January 4, 1940.

Table 12

Parasitism of Overwintering Cylindrocopturus longulus
Parent Adults by an Undetermined Parasite

Date	Unparasitized	Parasitized	Total
9/12/39	37	5	42
9/19/39	37	1	38
10/4/39	29	4	33
11/7/39	33	3	36
12/6/39	38	7	45
12/19/39	60	10	70
1/4/39	51	1	52
Total	285	31	316
Percent	91.2	9.8	100.0

Other Factors. In addition to the factors that have thus far been discussed, it is probable that others, such as predatory birds and climatic influences, are also effective in reducing the weevil population. No observations were made on the effects of these other factors.

Artificial Control.

No measures were developed for the control of this weevil on Douglas fir. In fact, as has already been pointed out, none seem necessary at present. Nevertheless, some consideration was given to investigating control measures for possible future use.

Since the immature brood spends the winter beneath the bark, there is the possibility of removing the infested branches and destroying the brood by burning. Considerable difficulty in doing this would be encountered, because many of the branches that harbor brood do not fade until after the beetles have emerged. Furthermore, many branches in which the beetles develop successfully do not die. Actually the presence of Cylindrocopturus longulus attacks can almost always be detected in the early spring by a careful search for the presence of discolored depressions in the bark over the larval mines. Such a detailed examination of every tree on a given area would be extremely costly and time consuming. Of course, a very considerable reduction in population would result from the removal of all obviously infested trees, but in following out such a course, even in a relatively light infestation, it might be necessary to practically denude the treated area—an effect far more drastic than as though the beetles were left to develop unhampered.

Destruction of the immature brood in the trees would still leave unaccounted the parent adults which overwinter on the trees. Presumably this would not alter the effectiveness of control, for it is believed that these parents do not lay any additional eggs in the spring, but this point has not been definitely established.

The long preoviposition period of a month or more when the new adults are in flight is a theoretically opportune time to conduct control. For example, it might be possible to dislodge the beetles from the trees upon which they are resting and destroy them in kerosene or some other toxic material. A somewhat similar procedure is one of the methods that has been suggested for reducing infestations of the white pine weevil, *Pissodes strobi* Peck in the eastern United States.

In order to test the practicability of this type of control, ten Douglas fir trees from 3 to 6 feet in height were chosen for experimentation. These trees were moderately to heavily infested by the 1938-39 generation, but all emergence had occurred by the time the first collection was made by beating on August 8. From then until November 7, 1939, several collections were made by beating the trees with a section of a shovel handle in such a way that the adults fell upon a cloth-covered frame where they could be collected. The results of these collections are shown in table 13. From this it appears either that not all of the adults were dislodged on any one date, or the trees became reinfested by flight from the surrounding area. In summarizing this experiment, it may be definitely stated that the method tested has little to recommend it because of its expense, its ineffectiveness, and the detrimental effects of repeated beatings upon the trees.

Should the necessity of direct control measures develop, it would be desirable to investigate the effectiveness of concentrated sprays, such as Mr. S. F. Potts has found effective against the white pine weevil and the Pales weevil in New England.

Table 13

Summary of Collections of Adult Cylindrocopturus longulus
Obtained by Beating Ten Selected Douglas Firs
at Pack Forest, La Grande, Wash., 1939

Date of Collection	Number of adults collected on a given date	Progressive total number of adults collected	Progressive percent of adults collected
8/8/39	130	130	36.1
8/10/39	75	205	56.9
8/15/39	36	241	66.9
8/22/39	53	294	81.7
8/29/39	21	315	87.5
9/5/39	10	325	90.3
9/12/39	13	338	93.9
9/19/39	14	352	97.8
11/7/39	8	360	100.0

SUMMARY

Cylindrocopturus longulus Lec. is widely distributed in the coniferous forests of North America. In the Pacific Northwest it is a minor pest of naturally established Douglas fir reproduction but is a potential threat to plantations. Damage increases under drought conditions.

An intensive study of the biology of C. longulus was made at La Grande, Wash., during 1939. In this vicinity there is one generation a year.

Larvae, parent adults, and perhaps eggs overwinter. Pupae develop in late April and are present until the last of July. Adults begin to form about May 20 but do not emerge for nearly a month. The last ones leave the branches by early August. There is a preoviposition period of about one month, during which time the adults feed upon the inner bark of small Douglas fir branches. In the open, oviposition takes place from the first of August to the first of October, but in the laboratory it may continue another three months. Practically all of the eggs hatch before winter, but a few may overwinter.

A fungus, Pullularia pullulans, is associated with C. longulus and seems to aid in overcoming the resistance of attacked trees.

Factors which were observed as reducing the C. longulus population are: Host resistance, competition among the larvae, and parasitism. Twelve species of hymenopterous parasites have been associated with this weevil.

Artificial control is considered unnecessary under present conditions. Two possible control measures, (1) destruction of the immature stages by removing and burning infested branches, and (2) elimination of adults during the preoviposition period by collecting them from their resting places on young trees, were investigated and found to be ineffective.

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Fig. 1. Small Douglas fir showing moderately heavy attack by <u>Cylindrocopturus longulus.</u> This tree has been repeatedly weeviled, but at the time the photo was taken the effects from weeviling were diminishing, as indicated by increased terminal growth.

Fig. 2. Small Douglas fir showing heavy attack by <u>Cylindrocopturus longulus</u>. Note that the terminal (broken) and all auxiliary laterals have been killed.

Fig. 3. Detail of typical twig killing by _Cylindrocopturus longulus_.

Fig. 4. Detail of typical twig killing by _Cylindrocopturus longulus_.

Fig. 4A

Detail of branch which has successfully overcome attacks by Cylindrocopturus longulus X 1½

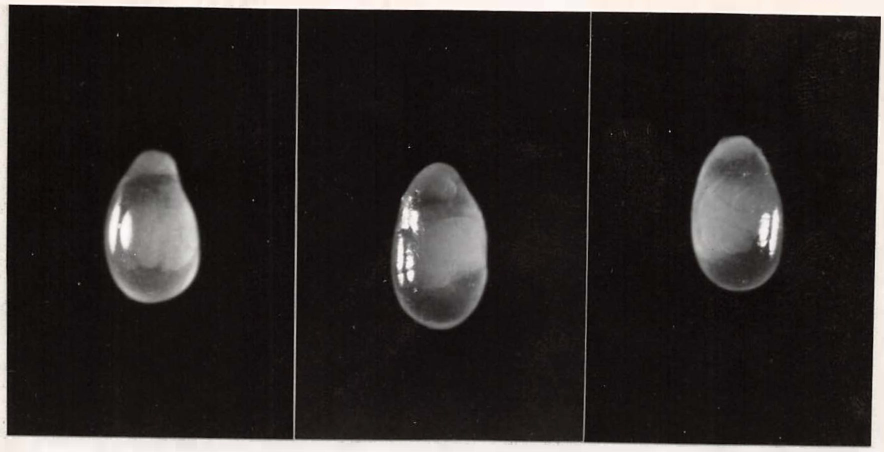

Fig. 5

Eggs X40

Fig. 6

Mature larva X 10

Fig. 7

Prepupal larva X 12

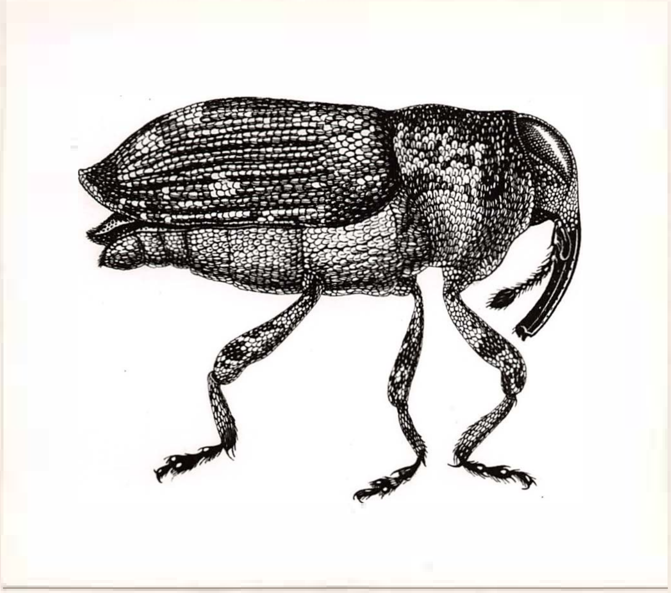

Fig. 8

Adult X 22